SARATOGA GAS LIGHT COMPANY, GASHOLDER NO. 2 ~~HOUSE~~ HAER No. NY-313
Niagara Mohawk Power Corporation Substation Facility,
Intersection of Excelsior and East Avenues
Saratoga Springs
Saratoga County
New York

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
Philadelphia Support Office
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19016

HAER
NY
46-SASPR
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HISTORIC AMERICAN ENGINEERING RECORD

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Location: Niagara Mohawk Power Corporation Substation Facility
Intersection of Excelsior and East Avenues
Saratoga Springs
Saratoga County, New York

UTM: 18.600310.4771350
Quad: Saratoga Springs, NY, 1:24,000

Date of Construction: 1873

Engineer: Unknown
Fabricator: Unknown
Erector: Unknown

Present Owner: Niagara Mohawk Power Corporation
300 Erie Boulevard West
Syracuse, New York 13202

Present Use: None. Structure has been abandoned for environmental safety reasons. Used for storage until Spring 1998.

Significance: Gasholder No. 2 is significant because of the role of gasholders in general in furthering residential and commercial development in urban areas. In addition, it is one of only a few remaining gas houses in the northeastern United States, a portion of the country where this type of industrial structure was once quite common.

Project Information: Documentation of Gasholder No. 2 was carried out at the direction of the United States Environmental Protection Agency (EPA), in consultation with the New York State Historic Preservation Officer, to mitigate the adverse effects of the proposed demolition of the structure. The EPA, as lead agency, acted to comply with Section 106 of the National Historic Preservation Act. Research was conducted by Grossman and Associates, Inc. (1993 and 1995). Additional photography and research as well as document reformatting were conducted by Panamerican Consultants, Inc.

Text from Grossman and Associates, Inc.
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Tuscaloosa, AL 35404

INTRODUCTION

The Saratoga Gas Light Company Gasholder No. 2 House is located at UTM Coordinates 4771350N and 600310E, Zone 18, Saratoga County, New York (USGS 7.5 minute Saratoga Springs quadrangle [1967]). The structure operated as a gasholder from 1873 until it was converted to a storage facility by 1932.

The Saratoga Gas Light Company Gasholder No. 2 House was first described in a Stage IA Archaeological Sensitivity Evaluation performed in 1990 by Hartgen Archaeological Associates.[1] The entire Niagara Mohawk Power Corporation (NMPC) facility was archaeologically investigated by Grossman and Associates, Inc. in 1993,[2] and the Gasholder No. 2 House was photogrammetrically documented in 1995.[3] In 1998, the National Park Service stated that information provided in the Grossman and Associates' reports would be "sufficient for compliance with the Memorandum of Agreement between the New York State Historic Preservation Officer and the U.S. Environmental Protection Agency, and accepted by the Advisory Council on Historic Preservation," if this documentation was prepared in accordance with HAER guidance.[4]

In May 1998, NMPC contracted with Panamerican Consultants, Inc. (PCI) of Buffalo, New York, to document the Saratoga Gas Light Company Gasholder No. 2 by "reformat[ing] previous archeological/ cultural work products into the Historic American Engineering Record (HAER) format and supplement previous work as necessary."[5] PCI conducted field drafting, photography and supplementary research between May 26 and June 1, 1998. This document is the product of those contracted activities.

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[1]Hartgen Archaeological Associates, Inc., *Report for Archaeologicol Potential, SEQR Parts IA & 3. Niagara Mohawk Power Corporation Site Remediol Investigation and Feasibility Study, Excelsior (Spring) Avenues, City of Saratoga Springs, Sorotoga County, New York*, 1990.

[2]Grossman and Associates, Inc., *Stage II Archaeological Dato Recovery and Mitigation Results of the Investigation of the Historic Cool Gasification Works at the Niagara Mohawk Power Corporation Site, Saratogo Springs, Saratogo County, New York* (New York: Grossman and Associates, Inc. report submitted to NMPC, Syracuse, New York, 1993).

[3]Grossman and Associates, Inc., *Supplemental Photogrommetric Recording of Interior and Exterior Structural Elements of Gasholder No. 2, Niagaro Mohawk Power Corporation Site, Sarotoga Springs, New York* (New York: Grossman and Associates, Inc. report submitted to the NMPC, Syracuse, New York, 1995).

[4]NMPC's Scope of Services with PCI (Letter from William R. Jones to Michael A. Cinquino, dated April 8, 1998). As a result, the narrative history of coal gasification plants (beginning page 3) and the discussion of the geo-archaeological engineering history and reconstruction (beginning page 25) prepared by Grossman and Associates, Inc. has been reproduced at the direction of NMPC. During a follow-up conversation, Mr. Jones stated that NMPC purchased and paid for the Grossman and Associates reports and that Grossman and Associates did not possess any copyright to the products. Although NMPC does not have explicit permission from Grossman and Associates to reuse their work, Mr. Jones averred that the reports are the property of NMPC and that reformatting them is not a problem (William R. Jones, personal communication, September 14,1998).

[5]NMPC's Scope of Services with PCI (dated April 8, 1998).

THE HISTORIC CONTEXT OF COAL GASIFICATION PLANTS AND HISTORY OF GAS ILLUMINATION[6]

Coal gas, when used as an illuminant, burns with a characteristic yellowish luminous flame. The history of European experimentation with the illumination properties of coal gas date to the seventeenth and early eighteenth centuries in England, and to the mid 1780s in Belgium and France. In 1664 an Englishman, John Clayton, discovered a pool of natural gas near a coal mine in Wigan, near Lancashire. Presumably intrigued by the possibility of using gas for illumination, be successfully experimented with extracting coal gas through distillation.[7] In 1726, another Englishman, Stephen Hales, determined that 158 grams of Newcastle coal would yield 180 cubic inches of "inflammable air," and soon after in 1733, Sir James Lowther sent specimens of distilled coal gas to the Royal Society in London for evaluation.[8] Independently, Jean Pierre Minckelers first demonstrated gas illumination in Belgium in 1784. Likewise, at about the same time in Paris, Phillipe Lebon was also experimenting with the distillation of gas from coal and other materials for domestic use. By 1799, Lebon patented a "thermo-lampe," which operated using gas distilled from wood.[9]

Table 1. A Comparative Chronology of the Saratoga Springs Facility Relative to European and American Developments in Coal Gasification Technology.

Date	Saratoga Springs	United States and Europe
1664-1733		England: Various experiments in coal gas distillation
1784		Belgium: Experiments in coal gas distillation
1784		France: Experiments in coal gas distillation in Paris
1792		England: First home lighted by gas produced in iron retorts in Redruth, Cornwall
1795		England: Experimental gasworks built near Birmingham
1798		England: Factory and shops lighted by gas in Birmingham
1806		Newport, Rhode Island: First home lighted by gas
1807		England: First gas streetlights installed in London
1809		Philadelphia, Pennsylvania: Masonic Hall designed with gas plant
1813		England: Westminster bridge in London lighted by gas
1813		England: London and Westminster Gas Co. gasworks built
1814		England: St. Margaret's, Westminster, London: first district lighted
1815		France: First coal gas development company established in Paris
1816		Baltimore, Maryland: R. Peale's museum lighted by gas
1816		Baltimore, Maryland: First gasworks built

[6]Grossman and Associates, Inc., 1993, pp. 10-30. This section and the following section on the history of the Saratoga Springs works (pp. 3-22) is taken directly from the referenced report, with minor alterations.

[7]*Encyclopaedia Britannica*, 1964, Volume 14, s.v. lighting gas, p. 102.

[8]Ibid.

[9]Ibid.

Date	Saratoga Springs	United States and Europe
1816		Philadelpbia, Pennsylvania: C.W. Peale's museum lighted by gas
1816		New York, New York: Gas streetlight experiments
1817		France: First gasworks built in Luxembourg area of Paris
1818		France: Gas streetlights installed in Paris
1823		Boston, Massachusetts: Gas streetlight experiments
1826		Germany: Unter Den Linden lighted, Berlin
1834-1836		Philadelphia, Pennsylvania: First gasworks built at 23rd and Market Streets
1848		Troy, New York: Troy Gas Light Co. gasworks established
1851		Philadelphia, Pennsylvania: Second gasworks built at Point Breeze
1853	First gasworks built at old site in Saratoga Springs, one building, one gasholder	
1868-1873	Second gasworks built at Excelsior Avenue; one building, Gasholders Nos. 1 and 2	
1873		Troy, New York: Gasholder and house built
1875		Troy, New York: Troy Citizens Gas Light Co. gasworks built
1886	Carburetted water gas process introduced; plant expansion including construction of generating bouse, storage facilities	
1887	Installation of electric plant; possible construction of purifying building; possible construction of "Holder 3," tar/water separator	
1888		Concord, New Hampshire: Gasholder and house built
1897	Gasholder No. 4 constructed	
1901	Gasholder No. 5 constructed	
1903	Installation of 2 boilers, construction of 125-foot stack and substation building	
1924	Gasholder No. 6 constructed	
1929	Gas production terminated	
1930	Plant becomes storage/distribution facility	
By 1932	Demolition of Gasholders Nos. 1, 4 and 5: Gasholder No. 2 House converted to garage	
1948		Pbiladelphia, Pennsylvania: Introduction of natural gas ends manufactured gas era at Point Breeze works
1950	NMPC acquires site	
1958-1959	Demolition of gas plant buildings	
1959	Construction of NMPC service center facility	
1960	Demolition of Gasholder No. 6	
1973	Construction of NMPC maintenance garage	

While these early demonstrations of the feasibility of using coal gas for lighting have been documented in England and Europe on an experimental basis, William Murdock of England is usually given credit for being the first to apply coal gas illumination on a sufficient scale to demonstrate its potential commercial exploitation.[10] In 1792, Murdock lighted his home in Redruth, Cornwall, with the gas being produced in large iron retorts and conveyed through metal pipes. Following this successful venture, Murdock set up a small, experimental plant in 1795 near Birmingham. By 1798, Murdock had installed lighting in a Birmingham factory and soon was providing gas commercially for several shops in the vicinity. In recognition of his achievement, William Murdock was awarded the Rumford medal of the Royal Society.[11]

Nevertheless and despite this early success, overall public opinion in England was against gas lighting at the turn of the nineteenth century. The new illuminant was denounced as "dangerous and impractical," an attitude which considerably slowed its adoption.[12] External military developments and economic factors appear to have played a part in the development and industrialization of the coal gas distillation process in England during the first decade of the nineteenth century. Following Napoleon's rise to power and the founding of the First Empire in 1804, the French blockade of British ports raised the cost of imported oil, making domestically produced coal gas a relatively cost effective and self sufficient source of fuel for illumination.[13]

In 1807, the first public installation of gas lights in London was accomplished, largely through the efforts of German born F.A. Winsor (or Winzer). For dispelling the public prejudice against illuminating gas in England, Winsor is referred to as "the father of gaslighting."[14] By 1813, Westminster Bridge in London was lighted by gas and by 1814, St. Margaret's Westminster, London became the first district illuminated by gas.[15] These successes led to the founding of the London and Westminster Gas Company, the predecessor to numerous similar nineteenth century gas companies across England.[16]

In France, during the first two decades of the nineteenth century, a similar developmental history of the use of coal gas for illumination can be traced. In 1815, the first coal gas distillation development company was founded in Paris by F.A. Winsor and chemist Friedrich C. Accum.[17] Accum was born in Hanover, now in Germany, but moved to London in 1793, and by 1800 was the proprietor of a shop and laboratory on Compton Street in Soho, London, advertising as an "Experimental Chemist."[18] Accum was an early teacher of chemistry, a manufacturer of chemical apparatus for other chemists in England as well as abroad, and a leading proponent of its utility for providing advances in industrial production and to public health. One of the most influential of Accum's many publications was a "Practical Treatise on

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[10]*Encyclopaedia Britannica*, Volume 4, s.v. coal gas, p. 6.
[11]Ibid.
[12]Ibid., Volume 14, s.v. lighting gas, p. 102.
[13]Maurice Daumas, "Domestic Comfort and Sanitation", in *A History of Technology and Invention, Volume III,* ed. Maurice Daumas (New York: Crown Publishers, Inc., 1979), p. 463.
[14]Ibid.
[15]Bernard Grun, *The Timetables of History*, 3rd revised edition (New York: Simon and Schuster Publishers, 1991).
[16]*Encyclopedia Britannica*, Volume 14, s.v. lighting gas, p. 102.
[17]Daumas 1979, p. 463.
[18]Gerard L'E Turner, *Nineteenth Century Scientific Instruments* (Berkeley and Los Angeles: Sotheby Publications, University of California Press, 1983), p. 211.

Gaslight" in 1815.[19] While in France, the partnership of Winsor and Accum was joined by Samuel Clegg, an engineer who had been involved in coal gas distillation experiments for a number of years. Clegg had developed the first process to purify gas by "bubbling" it in limed water.[20] This British-French cooperation after the earlier era of Napoleonic hostilities was also manifested by the fact that in many French cities, the development of coal gas production facilities was undertaken by English companies, starting ca. 1830.[21]

In 1817, the first gasworks were built in the Luxembourg area of Paris, and by 1818, the city adopted gas for street lighting.[22] Numerous additional gasworks were built within the city of Paris until ca. 1855, when all surviving gas companies were merged to form the "Compagnie Parisienne du Gaz," and all former gasworks within the center of the city were dismantled and new, large plants were built on the outskirts of Paris.[23]

Thus, while the technology for gas illumination was initially developed and perfected in England during the late eighteenth century and early nineteenth century, the use of gas lighting for homes, streets, and factories in England and other European cities did not become widespread until the second decade of the nineteenth century.

Following the discovery of the ability to produce gas from coal, and the unquestionable success of gas lighting for residential and commercial uses in England and Europe, gas lighting on a wide scale got its start in the United States in 1816, in Baltimore, Maryland. While isolated trials had been conducted in other American cities prior to this time, the introduction of gas lights in Rembrandt Peale's museum in Baltimore in 1816 was an unparalleled, precedent-setting success. In June 1816, the Baltimore City Council passed an ordinance permitting Peale and others to manufacture gas, lay pipes in the city's streets, and to issue contracts with the municipal authorities to provide street lighting.[24] This rapid adoption of the new technology in the United States appears to have been, in large part, due to its widespread use and prior acceptance in England and Europe.

The city of Philadelphia was a pioneer in the development of coal gas manufacturing plants to provide gas illumination for residential and commercial purposes. As early as 1803, a Philadelphia citizen, Benjamin Henfrey, was interested in the then new technology of gas illumination, and was urging the City Councilmen to develop a system of gas lighting by extracting gas from coal and burning it atop towers for public lighting.[25] But in 1803, the Philadelphia City Council was wary of manufacturing gas for public use, due to a widespread concern over the potential for leaks, explosions, and noxious odors.[26]

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[19]Ibid.
[20]Daumas 1979, p. 463.
[21]Ibid.
[22]Ibid.
[23]Ibid.
[24]*Encyclopaedia Britannica,* Volume 10, s.v. gas industry, pp. 13-14.
[25]John L. Cotter, Daniel G. Roberts, and Michael Parrington, *The Buried Past: An Archaeological History of Philadelphia* (Philadelphia: University of Pennsylvania Press, 1992).
[26]Ibid.

The private sector was more willing to adopt gas for lighting. In 1809, William Strickland designed the Masonic Hall, and his plans included a plant for manufacturing gas.[27] In 1816, Charles Willson Peale, the famous eighteenth century artist and father of Baltimore's Rembrandt Peale, installed a retort to manufacture gas for lighting his museum in Independence Hall. The retort was located in the tower room above the second floor of the museum.[28] In 1822, also within the private sector, the second Chestnut Street Theater opened and was illuminated by gas produced by a generator on the premises.[29] These private sector ventures were met with widespread public approval and enthusiasm, and laid the foundation for the building of gasworks to provide illumination for public use.

The construction of Philadelphia's first city gasworks was begun in 1834, largely due to the efforts of Samuel V. Merrick, a prominent engineer and founder of the Franklin Institute.[30] The site of the works was located at Twenty-third and Market Streets near the Schuylkill River. The gasworks complex was designed by Merrick who used London's Regency Park Gasworks as his model. The Philadelphia works, completed in 1836, included a retort house with 30 retorts, a purifying house, a meter room, a laboratory, and two gasholders. The gasholders were constructed of cast iron trusswork, and were not enclosed in a gasholder house. By 1837, one year after the gasworks was in production, the first gas street lamps were installed in downtown Philadelphia.[31]

Demand for gas increased dramatically and several structures had to be added to the Market Street works to meet the demand. By 1850, the plant had four retort houses and eleven gasholders, with a total capacity of 1.68 million cubic feet.[32]

In spite of the expansion of the gasworks and increased production and storage capacity, by 1850 it was soon recognized that a second facility was needed to meet the ever-increasing demand. John C. Cresson, who had succeeded Samuel Merrick as chief engineer of the gasworks, was urging the city to build another gasworks, this time beyond the city limits.[33]

The site chosen was a 75-acre tract of land fronting the Schuylkill River at Point Breeze, which was situated approximately 2.5 miles to the south of the first gasworks. Construction began in 1851 and gas was being produced by 1854. The complex was built to the specifications of John C. Cresson, and the buildings were constructed of gray granite with cast iron roof trusses covered with slate.[34] The retort house had 72 retorts, each capable of holding 250 pounds of coal, and pneumatic pumps were used to propel the gas to the purifying house. After being condensed and purified, the gas then passed through the meter house where meters registered production, and from there the gas was piped into the gasholder.[35]

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[27]Ibid.
[28]Ibid.
[29]Ibid.
[30]Ibid.
[31]Ibid.
[32]Ibid., p. 314.
[33]Ibid.
[34]Ibid.
[35]Ibid.

The gasholder at the Point Breeze Gasworks was 160 feet in diameter, with a capacity of 1.8 million cubic feet, and appears to have been the largest such structure built to date (1854). It was constructed of 12 cast iron towers connected by open work, iron girders. It was not enclosed within a gasholder house. During a snowstorm in 1854, the gasholder partially collapsed, and was not completed until 1856. The collapse was later attributed to shoddy materials and workmanship.[36] However, the collapse did not affect production, as the gas was diverted to the gasholders located at the first gasworks on Market Street.

The Point Breeze Gasworks survived the introduction of electric light during the 1880s due to the contemporaneous introduction of gas furnaces and stoves. This created a new market for coal gas beyond that of street lighting, and the facility then became one of the world's major generators of coal gas. In 1948, the introduction of natural gas into Philadelphia precipitated the demise of the facility.[37]

New York was not far behind Maryland and Pennsylvania in terms of promoting the development of gas illumination following the product's successful earlier implementation in England and other European countries. Possibly the first, and if not, one of the earliest efforts to introduce gas illumination to New York came about in February 1812, when a petition to the State Legislature was circulated, involving the granting of exclusive rights to a few indivlduals to "light cities and factories" for a period of fourteen years.[38] This project was opposed, and this exclusive privilege or monopoly was declared to be "injurious to the manufacturing interests of the State."[39]

In contrast to Philadelphia and Baltimore, the introduction of illuminating gas to New York City did not spur its immediate and widespread adoption by either the public or private sectors. Rather, the New York City Common Council proceeded slowly within its bureaucratic framework. In 1812, the Common Council's Watch and Lamp Committee suggested that "... an experiment be tried by using gas in the lamps in front of City Hall or some other suitable place," probably in response to the State Legislature's reaction to the above mentioned petition involving exclusive rights to a few individuals.[40]

In 1816, an extensive report was presented to the Common Council, which included an explanation of gas manufacturing and its growing acceptance for lighting in both European and American cities. The council then appointed a select committee, under the superintendence of Mr. Robert Hare, with powers "... to institute an experiment on gas lights ..." with a sum of money put at their disposal for such a purpose.[41]

In 1817, the Arts and Sciences Committee presented their report of successful experiments with gas lighting to the Common Council. However, the committee also reported that the cost was much higher in comparison to lighting with oil, and therefore recommended that the city not take on such an expense. The committee, against such an expenditure by the city, added a final statement to the report to the effect that they "... have no doubt

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[36]Ibid., p. 317.
[37]Ibid.
[38]I. N. Phelps Stokes, *The Iconography of Manhattan Island 1498-1909, Volume III* (New York: Arno Press, 1926), p. 491.
[39]Ibid.
[40]Ibid., *Volume IV*, p. 1563.
[41]Ibid., *Volume V*, p. 1587.

that individuals or a company would find it profitable."[42] Despite this recommendation, the Common Council decided to illuminate several streets in lower Manhattan with gas, bearing the expense of conducting the gas from the main pipe to the lamps, as well as their lighting and extinguishing.[43]

In 1823, the first franchise to supply the city with gas for illumination was given by the Common Council to the New York Gas Light Company. This franchise gave the company "the sole and exclusive privilege and right" of laying pipes and supplying gas to most of lower Manhattan with certain conditions. The contract stated that by May 12, 1825 the company should "erect and complete good and sufficient buildings, works, and apparatus for the preparation and manufacture of gas," lay cast iron pipes to convey the gas, and "manufacture and supply in the most approved manner sufficient quantities of the best quality gas, commonly called inflammable gas."[44] Some questions were raised by the term "best quality gas," and it was settled between the city and the New York Gas Light Company that British gas would serve as the standard, and "[t]he contract stipulated that the light of the lamps should be of a quality, brilliancy, or intensity, equal to the gas in use for the public lamps in the City of London."[45]

By April of 1824 the company was producing gas, and following the first public exhibition of its gas lights in a home at 286 Water Street, an April 23, 1824 *New York Evening Post* account reported that, "All doubt as to it's [sic] practicability was at once removed. In point of economy, safety and cleanness, it appeared perfectly obvious that this mode of lighting our streets, public buildings, manufactories, and dwelling houses, surpasses every thing of the kind that has hitherto been attempted by oil or candles."[46] Thus, from the 1820s gas lighting was widely adopted throughout the public and private sectors of New York City, and gas remained the most efficient and economical mode of illumination until eclipsed by the advent of electric lighting.

Finally, in addition to its adoption for illumination, the history of coal gasification was also impacted by the gradual emergence of scientifically useful and commercially viable by-products of the production process. The exploitation of secondary by-products coalesced over a 20-year period between the 1820s and the 1840s, and preceded the initial installation and construction of the Saratoga Springs gasworks by 30 or 40 years. As of the 1830s, the early gas produced was accompanied by a disagreeable odor of sulphurated hydrogen. This problem did not go away until 1849, when Frank Clark Hills introduced ferrous oxide as an effective purifying material.[47] Despite early developments in the gas production industry during the 1820s and 1830s, the manufacture and purification processes were not perfected until after the middle of the nineteenth century, and continued with little change until the first quarter of the twentieth century.[48] As a general description of the process, Daumas states that:

> Upon leaving the retort, the gas passed through a drum, where it was bubbled in water, which isolated the retort from the rest of the cycle. The gas then passed

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[42]Ibid., *Volume V*, p. 1590
[43]Ibid.
[44]Ibid., p. 1629.
[45]Ibid.
[46]Ibid., p. 1638.
[47]Maurice Daumas, "The Rise of Heavy Chemical Industry", in *A History of Technology and Industry, Volume III*, ed. by Maurice Daumas (New York: Crown Publishers, Inc., 1979) p. 574.
[48]Ibid., p. 573

> through a network of cooled tubes in which the tar condensed, then into a vat lined with lime or various materials to purify the gas, which was finally collected in a gasometer.[49]

The realization of the potential utility of coal tar by-products of the coal gas manufacture process began ca. 1815, with the utilization of tar for treating rope and as an air-tight sealant around gas pipe fittings and fixture outlets by 1820. By 1833, British factories had begun to sell small amounts of ammonia and chloride; however, these small scale applications of the secondary by-products did not emerge as a major aspect of the gas production process until the introduction of chemical fertilizers after the middle of the nineteenth century.[50] However, early commercial uses of coal tar by-products preceded the advent of chemical fertilizers by some 20 to 30 years. The active distillation of coal tar began around 1830, creosote began to be used in 1838 to protect railroad crossties, and about the same time, pitch or tar began to be employed for the surfacing of roads.[51]

While these "heavy" by-products of coal gas production were used and disseminated prior to the American Civil War, the major technological impact of this young industry revolved around the fact that the "lighter" distillation products, such as benzene and toluene, for the first time became readily available to laboratory chemists. This availability, in turn, brought about the promulgation of the first theories and models of organic chemistry. By the beginning of the second half of the nineteenth century, research by Perkins resulted in the emergence of the new industry of artificial dyes, which elevated coal tar from a problematic by-product to a highly valued economic commodity.[52]

THE DEVELOPMENTAL HISTORY OF THE SARATOGA SPRINGS SITE

Based on the results of Grossman and Associates, Inc. 1993 field and archival investigations, the history of the Saratoga Springs coal gasworks can be divided into five chronological phases:

- Phase I dates from 1868 to 1885, and includes the site's acquisition, the construction of the original main building and Gasholders Nos. 1 and 2, and the manufacture of gas using the coal carbonization process.
- Phase II dates from 1886 to 1902, and includes the introduction of the carburetted water gas process and the expansion of the facility. The expansion involved the construction of the purifying building, the generating house, the tar/water separator, or "Holder 3," Gasholders Nos. 4 and 5, and the coal and oil storage and transfer buildings.
- Phase III ranged between 1903 and 1929, and included further expansion of the facility, such as the installation of two large boilers, and the construction of a large brick stack, a substation building and transformer yard, and Gasholder No. 6.
- Phase IV, from 1930 to 1957, marks the end of the manufactured gas era of the site, the conversion of the plant to a storage and distribution facility for gas manufactured elsewhere, the demolition of Gasholders Nos. 1, 4, and 5, the coal

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[49]Ibid.
[50]Ibid.
[51]Ibid.
[52]Ibid.

house, the generating house, and the oil storage buildings, and the conversion of the Saratoga Gas Light Company Gasholder No. 2 House into a storage garage.

- Phase V dates from 1958 to 1993, and includes the demolition of the remaining manufactured gas plant buildings and Gasholder No. 6, and the construction of the Niagara Mohawk Power Corporation facility's service center and garage.

The history of manufactured gas (coal gas) production at the Saratoga Springs facility parallels the general technological and chronological changes observed throughout the industry during the mid and late nineteenth century. The basic technological shifts at the Saratoga Springs works can be documented in the historic record, and to some degree in the cartographic record, by the change from the originally implemented coal carbonization process of the initial 1873 facility, to the production of carburetted water gas sometime around 1886, and finally to the cessation of gas production in 1929 when the site was converted to a gas storage and distribution facility. Each of these technological shifts is reflected cartographically as changes in the physical site layout by the addition, conversion, or demolition of structures through time.

The initial process for the production of manufactured coal gas at the Saratoga Springs facility was the coal carbonization process. Generally, this process, known as destructive distillation, entailed the baking of bituminous coal at temperatures of between 600 and 700 degrees, in the absence of air, to produce coal gas for illumination purposes. This process included several condensation and purification stages to improve the illumination potential of the gas, and to remove the condensable materials from the final gas product, which were perceived at the time as dirty and/or harmful by-products. Minimally the operation would require a retort house, a purifying house, a meter room, a laboratory, gasholders, and offices.

This original coal carbonization process produced between 10,000 and 15,000 cubic feet of gas per ton of coal, which ranged in quality from 20 to 50 candles, or units of illumination.[53] The *Encyclopaedia Britannica* estimated the thermal efficiency of the initial carbonization process at 71.6 percent "...for every 100 heat units contained in the coal carbonized, 24 will appear in the gas, 42 in the coke available for sale after the heating of the retorts has been provided for, and 5.6 in tar, which means that 71.6 of the original 100 heat units have been obtained in the available useful products of carbonization."[54] In addition to the coal gas, many of the nineteenth century by-products of the manufacturing process were marketable as well. These included ammonium sulfate for fertilizer, toluol, cresol, naphthalene, and anthracene used in the production of dyes, medicines, perfumes, disinfectants, solvents, and paints, and the distilled tar, tar oil, and pitch for building materials, roofing felts, and road construction. "The average yield of tar by the ordinary gasworks process can be taken as 5% of the weight of coal carbonized."[55]

In 1873, an American named T.S.C. Lowe developed a new process for producing manufactured coal gas, called the carburetted water gas, or CWG process. This process used the introduction of steam through the coke bed, and injection of light oil into the superheated gas stream to increase the volume of gas produced, without reducing the thermal efficiency or illuminating quality of the resultant gas. The extent of carburetion employed was influenced by the cost of oil, and the thermal efficiency desired. "In Great

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[53]John Hornby, *A Textbook of Gas Manufacture for Students* (London: Bell and Sons, 1896), p. 8.
[54]*Encyclopedia Britannica* 1964, Vol. 10, s.v. gas industry.
[55]Ibid.

Britain, carburetting is usually continued until the calorific value of the carburetted water gas approximates that of the coal gas made at the same works, say 500 BTU."[56]

The carburetted water gas process was introduced in Saratoga Springs in 1886, and was the only process in use after 1890. As detailed below, the 1886 expansion of the site included several structures associated with this new technology, namely a gas generating house, boilers, a coal house, and a coal and oil transfer facility.

The first gasworks plant in Saratoga was initiated in 1852 when the trustees of the village granted a franchise to the engineering firm of Mott and Ayers of New York City for its construction. Building commenced in July of 1853 at the site located on the southeast corner of Lake Avenue and Hodgeman Street.[57] This gasworks, owned and operated by the Saratoga Gas Light Company, consisted of one, small, 40 by 25 foot building and a 25,000 cubic foot gasholder.[58]

During the laying of the gas lines and service pipes, the general public became greatly concerned about gas escaping the pipes and killing the shade trees which had become Saratoga's hallmark.[59] In response to public outcry, the Saratoga village trustees passed an ordinance in September 1853 stating that the gas pipes were to be laid in the streets, "no closer to the shade trees lining the streets, than down the center of the streets."[60] The Saratoga Gas Light Company apparently continued to lay its pipes, not following the ordinance, and the village took legal action to recover penalties which had been outlined in the ordinance. Eventually, the New York State Supreme Court awarded the Village of Saratoga $109.69 in damages.[61] The Saratoga Gas Light Company continued to extend the mains as demand increased until ca. 1873, when the second Saratoga Springs Gasworks (the project area) began production.[62]

The current project site was acquired in ca. 1868 by the Saratoga Gas Light Company to construct the second manufactured gas plant in Saratoga. The present site, located north of Excelsior Avenue, lies approximately five blocks north of the first works at Lake Avenue.[63] The 1866 Beers Atlas of Saratoga, which pre-dates construction activity on the site, depicts the project area as vacant land traversed by an eastward flowing drainage of Village Brook.[64]

During a 1989 interview conducted by Atlantic Environmental Services, Inc. personnel with retired gasworks employee Frances Cunningham, reasons for the selection of the Excelsior Avenue site were discussed. It was mentioned that the location was chosen because it was at a lower elevation than the rest

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[56]Ibid.

[57]Saratogian, *Gas Storage Building, One of Few in Existence, Saratoga Sketches No. 12* (Saratoga Springs, New York: Community Development Office, City Hall, January 4, 1976).

[58]Hudson River Water Power Company, "Saratoga Gas, Electric Light and Power Plant and Company." In *The Story of a Great Enterprise* (Albany, New York: Weed-Parsons Printing Company, 1903).

[59]Saratogian 1976.

[60]Ibid.

[61]Ibid.

[62]Hudson River Water Power Company 1903.

[63]Atlantic Environmental Services, Inc., *Work Plan for Remedial Investigation and Feasibility Study for the Niagara Mohawk Power Corporation Site, Saratoga Springs, New York* (Submitted to the NMPC, Syracuse, New York, March, 1990).

[64]Ibid.

of the city, and the natural tendency for gas to rise precluded the use of pumps to force the gas to the distant users. In addition, the presence of a nearby water source, Village Brook, necessary for the gas manufacturing process as well as the gas seals, may have been an important consideration. Easy access to railroad lines for the transport of the coal and other materials to and from the plant was available, as the Delaware and Hudson Railroad line passed just north of the site.[65] Additionally, and although not addressed in the interview, the presence of buried clay soils may also have been important in the construction of the new, below-grade gasholders.

The construction of the gasworks at the site appears to have been undertaken over a five-year period between ca. 1868 and 1873, as gas was documented as being manufactured by the latter date.[66] The original building erected was one-and-a-half stories high, constructed of brick, and measured 30 by 100 feet.[67] The gasworks plant would have also had to include retorts, a purifying area or house, a meter house, and gasholders as necessary components of the gas manufacturing process. The 1874 Cramer map of Saratoga from Congress Street to Excelsior Spring depicts a rectangular building, oriented roughly east-west, with a small extension to the south on the eastern half, as well as the presence of two circular gasholders to the east of the main building (Gasholders Nos. 1 and 2).

According to the site chronology as presented in the previous studies done for the plant's history, the purifier house located to the south of the main rectangular structure was built by 1873 as part of the initial phase of plant construction.[68] No surviving cartographic evidence corroborated this date. The building was not depicted on the 1874 Cramer map or on the 1876 Beers Combination Atlas. The first possible depiction of this purifier house structure is the aerial lithograph of 1888, which shows either a separate building or an extension to the south of the main rectangular structure. This cartographic evidence suggests that the purifying house may not have been present until the decade of the 1880s.

In 1876, the assets of the Saratoga Gas Light Company were sold, and the Saratoga Gas Company assumed control of the gasworks.[69] At this time, the complex consisted of a central retort house, a purifying building, and two gasholders.[70] The 1876 Beers Combination Atlas shows the original rectangular brick building, now with a large addition to the north, as well as two brick gasholder houses.

Also shown on the 1876 Beers Atlas is the line of the main sewer, which ran through the southern portion of the site, north of the channeled Village Brook, or "Gas Creek," as it was also known. A ca. 1875 map of the Main Sewer of Saratoga by William Vibbard is a detailed plan and profile of the (proposed?) sewer route as it crossed the gasworks project area along its general course down the Village Brook drainage.

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[65]Ibid.; Atlantic Environmental Services, Inc., *Draft Remedial Investigations Report, Niagara Mohawk Power Corporation Site, Saratoga Springs, New York* (Submitted to the Niagara Mohawk Power Corporation, Syracuse, New York, 1992).

[66]Atlantic Environmental Services, Inc. 1992; Hudson River Water Power Company 1903.

[67]Hudson River Water Power Company 1903.

[68]Hartgen 1990, Figure 2; Atlantic Environmental Services, Inc., 1990; Atlantic Environmental Services, Inc., 1992, Tables 1-3.

[69]Atlantic Environmental Services, Inc., 1992, Figure 1-7.

[70]Atlantic Environmental Services, Inc., 1990, p. 20.

Table 2. Chronology of the Saratoga Springs Coal Gasification Works.

Date	Description of Event
1868-1870	Acquisition of site by Saratoga Gas Light Company.[71]
By 1873	Construction of gasworks main building including retorts, purifying house/area, Gasholders Nos. 1 and 2. Gas produced by coal carbonization process.[72]
1874	Rectangular Main Building, Gasholders Nos. 1 and 2 only structures constructed.[73]
ca. 1875	Saratoga main sewer designed/constructed; rectangular main building with large extension to the north, Gasholders Nos. 1 and 2.[74]
1876	Assets sold to Saratoga Gas Company.[75]
1876	Gasworks consist of central retort house, purifying building, Gasholders Nos. 1 and 2.[76]
1876	Gasworks consist of rectangular main brick structure with addition to north, Gasholders Nos. 1 and 2.[77]
1886	Production process changes to carburetted water gas expansion of plant. Installation of boilers for steam generation, gas generating house north of original main building, coal house and oil and coal houses.[78]
1877-1888	Possible construction of purifying house building and "Holder 3" south of main brick building.
1887	Assets sold to Saratoga Gas and Electric Light Company.[79]
ca. 1887	Construction of electric generating facility-installation of one 50-light arc dynamo for lighting streets.[80]
1888	Gasworks consist of the rectangular main brick building, a smaller brick building (purifying house?), Gasholders Nos. 1 and 2 and the oil and coal storage and transfer buildings; East Avenue has been constructed across east end of site.[81]
1897	Assets sold to Saratoga Gas, Electric Light and Power Co.; construction of Gasholder No. 4, steel above-grade tank and water seal.[82]
1900	Gasometer Capacities: 1-50,000 cubic feet; 2-60,000 cubic feet; 4-30,000 cubic feet. Two scrubbers east of generating house; Gasholder No. 1 has drip box.[83]
1901	Construction of Gasholder No. 5 steel above-grade tank and water seal, capacity: 60,000 cubic feet.[84]

[71]Saratogian 1976; Hudson River Water Power Company 1903.
[72]Hudson River Water Power Company 1903; Atlantic Environmental Services, Inc., 1992
[73]L.H. Cramer, *Map of Saratoga: Congress Street to Excelsior Spring* (L.H. Cramer, C.E., 1874).
[74]William H. Vibbard, *Map of the Main Sewer of Saratoga Springs, New York* (At the City of Saratoga Springs Engineer's Office, Town Hall, 1875).
[75]Atlantic Environmental Services, Inc., 1992.
[76]Atlantic Environmental Services, Inc., 1990; Atlantic Environmental Services, Inc., 1992.
[77]S.N. Beers and D.G. Beers, *Topographic Atlas of Saratoga County, NY.* (Philadelphia: Stone and Stewart Publishers, 1866).
[78]Atlantic Environmental Services, Inc., 1992; Hudson River Water Power Company 1903.
[79]Atlantic Environmental Services, Inc., 1992.
[80]Hudson River Water Power Company 1903.
[81]L.R. Burleigh, *Lithograph of Saratoga Springs* (Troy, New York: L.R. Burleigh, 1888).
[82]Atlantic Environmental Services, Inc. 1992.
[83]Sanborn Map Company, *Insurance Map of Saratoga, Saratoga County, New York* (Pelham, New York: Sanbom Map Company, 1900).

Date	Description of Event
1903	Expansion of plant: installation of two 250 hp horizontal steam boilers, 125-foot brick stack, construction of brick substation building. Decommissioning of ca. 1887 electric generating plant.[85]
Ca. 1903	Circular below-grade feature surrounded by low fence shown south of purifying building ("Holder 3").
1906	Total holder capacity reported as 200,000 cubic feet.[86]
1911	Assets sold to Adirondack Electric Power Company; discontinuation of electric power generation onsite.
1919	Total holder capacity reported as 140,000 cubic feet (possible decommissioning of Saratoga Gas Light Company Gasholder No. 2, capacity 60,000 cubic feet).
1920	Assets sold to Adirondack Power and Light Corporation.
1924	Construction of Gasholder No. 6 steel triple-lift type: 500,000 cubic feet capacity above-grade water tank and seal. Total plant holder capacity reported as 700,000 cubic feet.
1928	Final complete year of onsite gas production.
1929	Manufactured gas era ends; plant converted to a gas storage/distribution facility; gas obtained from Schenectady and Troy facilities.
By 1932	Demolition of Gasholder and House 1, Gasholder No. 4 and 5, the coal house, generating house, ca. 1900; storage building, oil house and oil tank house; conversion of Saratoga Gas Light Company Gasholder No. 2 into garage.[87]
1933	"Holder 3," "tar/water separator," "tar pit" filled.
1950	Consolidation of the Niagara Mohawk Power Corporation
1958-1959	Demolition of remaining gas plant buildings: rectangular main building, purifying house.
1959	Construction of Niagara Mohawk Power Corporation service center facility.
1960	Demolition of Gasholder No. 6.
1973	Construction of maintenance garage building adjacent to service center facility.

Despite inconsistencies with known landmarks, as well as other historic depictions regarding scale and placement of the extant gasworks structures, this map does indicate that at this time, the plant included a main building and two gasholder houses. The gas plant continued essentially unchanged in structure and layout until ca. 1886 when the new manufacturing process of carburetted water gas was introduced, which necessitated the construction of new facilities.

The circular brick gasholder houses are enclosures containing Gasholder No. 1 and Saratoga Gas Light Company Gasholder No. 2, both initially depicted on the 1874 Cramer map. Gasholder No. 1 had a 50,000 cubic foot capacity and Gasholder No. 2 had a 60,000 cubic foot capacity. Both holders had below-grade water seals contained in pits over 20 feet deep.[88] The large above-ground brick gasholder houses at Saratoga Springs reflected industry-wide design protocols and represent a specific response to

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[84]Atlantic Environmental Services, Inc. 1992; Hudson River Water Power Company 1903.

[85]Hudson River Water Power Company 1903.

[86]Atlantic Environmental Services, Inc. 1992. The rest of the information in this table, except for footnote 92, is cited from Atlantic Environmental Services, Inc. 1992.

[87]Sanborn Map Company, *Insurance Map of Saratoga Springs, Saratoga County, New York* (Pelham, New York: Sanborn Map Company, 1932).

[88]Atlantic Environmental Services, Inc., 1990; Atlantic Environmental Services, Inc. 1992.

the technological challenges of coal gas production and storage in the mid-nineteenth century. A gasholder house is a structure that surrounds an iron gasholder, in which the gas is stored after being purified. According to Waite, construction of gasholder houses began in upstate New York during the early 1870s, following a practice already common in New England.[89] Most of the documented New York and New England gasholder houses were constructed of brick, although as of 1973, one surviving New England example in Warren, Rhode Island was built of stone.[90] The surviving New York and New England brick gasholder houses were built during the 1870s, with one exception in Concord, New Hampshire that was constructed in 1888.[91]

Gasholder houses were constructed for a variety of reasons, including those of climate and economy. As stated in Waite:

> The structure protected the iron holder from the elements and enabled it to be of thinner plates since the holder itself would not have to withstand wind pressure. Wind pressure acting on one side of the holder; snow loads on top of the holder; and icing of the guide and counter balance pulleys all tended to interfere with the holder's free and consistent vertical movement. The enclosure also prevented freezing of the water in the holder pit that formed a seal to prevent loss of gas, [in the case of below-grade gasholders] while allowing the holder to rise and fall.[92]

The gasholder house also reduced the condensation of gas during cold weather, which contributed to the economic incentives for its construction in areas of often severe winters, such as the upstate New York-New England region. However, "[t]he various mechanical problems resulting from the cold climate were ultimately overcome by improving the holder [as in the case of an above-grade steel enclosure] and thereby eliminating the need for a house."[93]

The illuminating gas produced at the Saratoga Springs gasworks beginning ca. 1873 was generated by the coal carbonization process.[94] Through this process, coal gas was produced by destructive distillation of bituminous coal, during which it is heated in retorts in the absence of air.[95] The quality and yield of gas is dependent upon a variety of factors including the type of coal, the temperature and time of carbonization, and the type of retort, either vertical or horizontal. The coal gas is then subjected to purifying processes before it is metered, measured by volume, and ultimately stored in the gasholder. The particulars regarding the design of the retorts and purifying process used at the Saratoga Springs gasworks are not known for this early phase of the plant's operation. From ca. 1873 until 1886 no documented changes are available for either the gasworks manufacturing process, or for the plant's physical configuration of the

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[89]Diane S. Waite, *Gasholder House 1873 Troy Gas Light Company, Troy (HAER NY-2): A Report to the Mohawk-Hudson Area Survey.* Conducted by the HAER, ed. Robert M. Vogel (Washington, D.C.: Smithsonian Institution, 1973), p. 44.
[90]Ibid., p. 48.
[91]Ibid.
[92]Ibid., p. 46.
[93]Ibid., p. 48.
[94]Ibid.
[95]*Encyclopedia Britannica,* Vol. 9, s.v. fuels-coal gas.

structures.[96] Although East Avenue was constructed across the eastern portion of the site between 1876 and 1888, it did not impact extant facility structures.[97]

In 1886, an "improved" process for the manufacture of gas was introduced.[98] This process, known as carburetted water gas generation is a cyclic process involving steam and oil injection.[99] By this method of manufacture, the coal gas is enriched with hydrocarbon gases produced by thermal cracking of oil, which takes place simultaneously with the water gas production.[100] The technological transition from coal carbonization to carburetted water gas generation brought about the need to expand the plant's facilities in 1886.[101] The 1886 expansion included the installation of "boilers for steam generation, a gas generating house (located north of the original retort house), a coal house, and an oil and coal transfer and storage facility associated with the railroad line to the north."[102]

In 1887, the plant was sold to the Saratoga Gas & Electric Light Company.[103] About the same time as the ca. 1886 expansion of the plant, "[a]n electric generating facility was added at the east end of the gas plant" to facilitate the new carburetted water process.[104] Additionally, "[t]he first electric plant was installed, consisting of one 50 light arc dynamo for lighting part of the principal streets of the village."[105]

No primary cartographic evidence corroborating this 1886 to 1887 expansion period was documented in the previous research studies.[106] The 1888 aerial lithograph of Saratoga Springs by L.R. Burleigh shows the site and vicinity, along with details of the site plan, which support the expansion of the plant as of this date. However, given the often schematic or "birds-eye view" representations of this type of documentary evidence, caution should be taken in weighing the validity of this map. Clearly shown on this lithograph are East and Spring Avenues, the main rectangular brick building, a small building or extension at the southeast corner of the main building, and the houses of Saratoga Gas Light Company Gasholders Nos. 1 and 2 with Gasholder No. 1 showing a small extension (drip house) on its southeast quadrant. Additionally, the lithograph depicts coal storage and transfer buildings adjacent to the Delaware and Hudson Railroad line. The small building depicted as extending to the south at the southeast corner of the main building may, in fact, be the first actual depiction of the late nineteenth century purifying house. It can be suggested that the purifying house dates from between 1877 and 1887, as it is not shown on the 1876 Beers Combination Atlas, and is shown on the 1888 lithograph. The same lines of evidence suggest that East Avenue was constructed across the eastern portion of the property within the same time period.

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[96]Atlantic Environmental Services, Inc. 1992; Hudson River Water Power Company 1903.
[97]Atlantic Environmental Services, Inc. 1992.
[98]Hudson River Water Power Company 1903, p. 99.
[99]Atlantic Environmental Services, Inc. 1990, p. 26.
[100]*Encyclopedia Britannica,* Vol. 4, s.v. coal gas.
[101]Hudson River Water Power Company 1903.
[102]Atlantic Environmental Services, Inc. 1990, p. 26.
[103]Atlantic Environmental Services, Inc. 1992.
[104]Atlantic Environmental Services, Inc. 1990, p.26.
[105]Hudson River Water Power Company 1903:99.
[106]Hartgen 1990; Atlantic Environmental Services, Inc. 1990; Atlantic Environmental Services, Inc. 1992.

The site chronology presented in the previous documentary studies lists 1889 to 1903 as the date range within which "holder foundation 3" was constructed. Initially believed to have been the foundation of a former gasholder, this circular, brick-lined, cement-faced, 60-foot diameter, below-grade structure was given the designation "Gasholder 3" when the gasholder construction sequence was tentatively identified in the earlier documentary studies.[107] However, no primary or secondary cartographic sources depict this feature or support this date attribution. It does not appear on the Cramer 1874 map, the 1876 Beers Combination Atlas map, the 1888 Burleigh Lithograph, or on the Sanborn Insurance Map of 1900. A 1903 photograph of the site shows a below-grade, circular, fenced feature in the foreground of the photo, and in front of the southeast corner of the extant purifying house. In 1965, the Niagara Mohawk Power Corporation conducted a structural evaluation of the Service Center building, as cracks were appearing in the foundation walls near the southeast corner of the ca. 1959 structure. A cross section of the foundation drawn at this time identified the brick wall of the "old water pit-brick gasholder 60' in diameter," as well as the identification of a rectangular feature as an "old tar separator-built inside the holder."[108] The Draft Remedial Investigation Report of September 1992 concludes that, "it appears that Gasholder 3 was either a short-lived gasholder facility, or was never completed as a holder and was retrofitted to serve as a tar/water separator."[109] Given the lack of cartographic evidence, and the absence of archival information regarding the originally intended function of this feature, the construction date and function of "Gasholder 3" remains open to further interpretation. The 1993 archaeological and boring evidence strongly suggests that "Gasholder 3" was never intended as a gasholder, was possibly built as functional element of the purifying house, and may be roughly contemporaneous with the advent of the carburetted water gas process in ca. 1886.[110]

In 1897, the assets of the Saratoga Gas & Electric Light Company were sold to the Saratoga Gas, Electric Light and Power Company who assumed control of the gasworks.[111] Improvements included the construction of a steel gasholder, with an above-grade water seal contained in a steel tank, Gasholder No. 4.[112] The capacity of this gasholder was listed as 30,000 cubic feet on the 1900 Sanborn Insurance Map. The 1903 photograph of the site shows this gasholder to be an iron frame construction of five vertical stays, fixed at equal distances around the circumference, with the top curb joined to the vertical stays by openwork girders. No trusswork is present at the top curb. Further improvements were made in the village of Saratoga Springs. By this time, "'[t]he old lamps used in lighting the village streets were displaced and incandescent street lamps were installed."[113] Also at this time "miles of street mains were laid to supply new (gas) customers."[114]

The Sanborn 1900 Insurance Map of the "Saratoga Gas Electric Light and Power Company" is the first map to identify the functions of extant structures on the site complex, including those erected ca. 1886, and the gasholders are identified by cubic foot capacity. The main building complex was identified with functional subdivisions which distinguished the presence of the coal house, the generating house, the

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[107]Atlantic Environmental Services, Inc. 1990, p. 26; Hartgen 1990, Table 1.

[108] NMPC 1983, Appendix II.

[109]Atlantic Environmental Services, Inc. 1992, pp. 1-17.

[110] Grossman and Associates, Inc., 1993.

[111]Ibid.

[112]Atlantic Environmental Services, Inc., 1990; Atlantic Environmental Services, Inc.,1992.

[113]Hudson River Water Power Company 1903, p. 99.

[114]Ibid.

boiler house, the electric light house, the engine rooms, and the office/storage area. Two "scrubbers" are depicted east of the generating house. Located to the north, near the tracks of the Delaware and Hudson Railroad, were the oil tank house and oil house. The purifying house, located south of the main complex and first depicted on the 1888 Burleigh lithograph, contains a subdivision labeled "lime house" to the north, and an extension to the east identified as the oil and meter house. A square building to the east of the coal house, at the northern end of the main building complex is labeled "storage," or possibly "carriage" house. This structure does not appear on the 1907 Adirondack Power and Light gasworks plant plan, or any subsequent maps. Three gasholders are shown. Gasholder No. 1 (and house) is labeled as having a 50,000 cubic foot capacity with a one-story drip house extension. Saratoga Gas Light Company Gasholder No. 2 (and house) was labeled with a 60,000 cubic foot capacity. Gasholder No. 4 was labeled as an iron gasometer with 30,000 cubic foot capacity. A pump house is indicated south of the three gasholders, near the southern property line. A double hydrant and 4-inch water line are shown between the main building complex and the gasholder area of the property.

In 1901, the increased demand for fuel necessitated the construction of an additional large gasholder.[115] Gasholder No. 5 was constructed with an above-grade water seal contained in a steel tank.[116] The 1903 photograph shows Gasholder No. 5 in the far background, and it appears to be of similar steel frame construction as Gasholder No. 4. Gasholder No. 5 post dates the Sanborn map of 1900, but it is shown on the Saratoga Gas, Electric Light and Power Company Site Plan dated 1907.[117] Capacity for this gasholder is listed as 60,000 cubic feet.[118]

The beginning of 1903 marked the advent of the third phase of major changes at the Saratoga Springs site. Improvements included the installation of two large steam boilers, the erection of a large brick smoke stack, the construction of a brick, electric substation building, and the decommissioning of the ca. 1887 electric light plant.[119] The expansion was described in a 1903 account as follows, "...it became necessary to abandon the small boilers and smoke stacks previously in use, and erect two large, horizontal tubular boilers of 250 horse power each, and one large brick stack 125 feet high, with a six-foot flue."[120] At this same time, a large brick substation "with the necessary transformers and other electrical devices of an up-to-date plant were installed."[121] The 1903 photograph and a 1905 aerial photograph show the new substation building and the 125-foot stack.

The demand for gas still continued to grow after the construction of Gasholder No. 5 in 1901. In 1906, the gasholder capacity of the Saratoga Springs plant was reported as 200,000 cubic feet.[122] This amount reflected the total capacity of the four extant gasholders: No. 1 - 50,000 cf.; Saratoga Gas Light Company

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[115]Ibid.
[116]Atlantic Environmental Services, Inc. 1992.
[117]Ibid., Figure 1-9.
[118]Ibid., Table 1-2.
[119]Ibid.
[120]Hudson River Water Power Company 1903, p. 99.
[121]Ibid., p. 101.
[122]Atlantic Environmental Services, Inc., 1992, Table 1-3.

Gasholder No. 2 - 60,000 cf.; No. 4 - 30,000 cf.; No. 5 - 60,000 cf.[123] In 1911 the plant was sold to the Adirondack Electric Power Corporation, and generation of electric power on-site was discontinued.[124]

In 1919, the gasholder capacity of the Saratoga Springs plant was reported as being 140,000 cubic feet.[125] Since the total capacity of the four gasholders was 200,000 cubic feet as reported in 1906, this decrease in capacity by 60,000 cubic feet by 1919 may have reflected the decommissioning of either Gasholders Nos. 2 or 5. Previous studies have suggested that this decrease probably reflects the decommissioning of Saratoga Gas Light Company Gasholder No. 2, although documentary or archival corroborative evidence is unavailable.[126]

In 1920, assets of the Adirondack Electric Power Corporation were sold, and the Adirondack Power and Light Corporation assumed control of the plant.[127] The 1922 Adirondack Power and Light Corporation Key Map shows a trolley line, probably operating between 1903 and 1928, crossing through the property near the intersection of East and Excelsior Avenues.[128]

In 1924, a fifth gasholder (Gasholder No. 6) was constructed at the northeast corner of the site. Gasholder No. 6 was a triple-lift, steel construction, gasholder with an above ground water seal contained within an above ground steel tank.[129] A photograph of the Saratoga Springs substation, dated June 1925, shows Gasholder No. 6 in the background, partially obscured by the Saratoga Gas Light Company Gasholder No. 2 House, with a capacity of 500,000 cubic feet.[130] The overall plant capacity was reported as 700,000 cubic feet in 1924.[131] This overall capacity suggests that Saratoga Gas Light Company Gasholder No. 2 (60,000 cf.) had not been decommissioned in 1919. It is, however, equally probable that the 1924 plant capacity could have been miscalculated, and should have been reported as being 640,000 cubic feet.

The Adirondack Power and Light Corporation was consolidated with the New York Power and Light Corporation in 1927, and the end of 1928 represented the last complete year of gas production at the site.[132] In 1929, on site gas production was terminated and the gas manufacturing era of the site's history ended. The facility was converted to a storage and distribution hub for gas manufactured at Schenectady and Troy, and piped to the Saratoga Springs plant.[133] Although not used for production, the gas generation equipment and extant buildings were maintained for supplemental production.[134]

The 1932 Sanborn Insurance Map of the plant showed that major changes had occurred since its conversion to a storage and distribution facility three years earlier. The following structures are believed

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[123]Ibid., Table 1-2.
[124]Ibid., I-21.
[125]Ibid., Table 1-3.
[126]Atlantic Environmental Services, Inc. 1990, p.26.
[127]Atlantic Environmental Services, Inc. 1992, Table 1-3.
[128]Atlantic Environmental Services, Inc. 1990, p. 29.
[129]Atlantic Environmental Services, Inc., 1992, p. 29.
[130]Ibid., Table 1-2.
[131]Ibid., Table 1-3.
[132]Ibid., p. I-21.
[133]Ibid., p. 29.
[134]Ibid.

to have been demolished, as they are not included in the 1932 map: Gasholders Nos. 1, 4, and 5, the coal house, the generating house, the storage building seen on the 1900 Sanborn map, and the oil house and oil tank house adjacent to the Delaware and Hudson Railroad line. Surviving structures on the 1932 map included the main brick rectangular building, the purifying house, the substation building, the former Saratoga Gas Light Company Gasholder No. 2 House (now a garage), a small valve house, a small heater building, Gasholder No. 6, and a transformer yard depicted adjacent to the brick substation building. It was suggested in the site chronology presented in the previous studies that the demolition of Gasholder No. 5 occurred between 1934 and 1941.[135] However, its absence on the 1932 Sanborn map documents that this gasholder had already been demolished prior to 1932.

The below-grade circular, brick lined, cement faced feature of "Holder 3," possibly a tar/water separator pit, was filled in during 1933, according to a former Niagara Mohawk employee whose father worked as a gas maker.[136] It again should be noted that no nineteenth century maps depict this below-grade feature.

The 1941 site "layout/fence" plan shows basically the same configuration of structures as the 1932 Sanborn Insurance Map. The exception is that the main brick building, or former generating house, is shown as a rectangular structure similar to its original ca. 1873 dimensions, and a free standing, "stack foundation" is located to its northwest. The former purifying and lime house with its eastern extension (the former ca. 1900 oil and meter house) was labeled "brick building" on the 1941 plan. The substation building and transformer yard, and the former Saratoga Gas Light Company Gasholder No. 2 House (now a garage) were shown as still present. Gasholder No. 6, built in 1924, was depicted as "Holder 6 Foundation," which may be in error because Gasholder No. 6 is shown extant with a 500,000 cubic foot capacity on the 1950 Sanborn map. Two small buildings, the valve house, and the heater house, shown on the 1932 Sanborn map were still shown in the same relative locations in 1941.

In 1950, the New York Power and Light Corporation was consolidated with the Niagara Mohawk Power Corporation, the present site owner.[137] The 1950 and 1952 Sanborn Insurance Maps showed basically the same configuration of structures on the site, but identified new functions for the remaining buildings. The main brick building, or former generating house, had been subdivided and utilized for laboratory, storage, and office space in the western half of the structure, and as storage on the eastern half of the structure. The main area of the former purifying house was adapted as a stock room, the former lime house was converted to an office, and the extension to the east, the former oil and meter house, was in use as a lineman's room by 1952. The substation, transformer yard, and small valve and heater buildings were still shown as standing with their original designations. The former Saratoga Gas Light Company Gasholder No. 2 House was labeled "truck and storage." The only extant gas related structure depicted was Gasholder No. 6, labeled as "Steel Gasometer" with a 500,000 cubic foot capacity. The Delaware and Hudson Railroad line and right-of-way were still shown as bordering the property along its northern edge.

During 1958 and 1959, the former gasworks buildings were demolished and the Niagara Mohawk Power Corporation Saratoga Service Center facility was built.[138] The new facility contained offices and a

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[135]Ibid.
[136]Ibid., p. I-23.
[137]Ibid.
[138]Ibid.

maintenance garage.[139] This structure was built primarily over the former purifying house and "Holder 3," as evidenced by borings conducted in 1965.

In 1960, Gasholder No. 6 was demolished.[140] A 1961 aerial photograph of the site showed the circular concrete foundation of former Gasholder No. 6 without its superstructure.[141] Also noted on the 1961 aerial photograph, in the southeast corner of the site, is a feature labeled "possible rail spur."[142] This most likely represents the trolley line indicated on the 1922 Adirondack Power and Light site plan.

In 1968, extensive highway construction was taking place along the northern boundary of the property.[143] As seen in the 1968 aerial photograph, New York Route 50 was under construction along the former right-of-way of the Delaware and Hudson Railroad.[144] Fill from this highway construction encroached onto the northwestern corner of the property.[145]

In 1973, the modern maintenance garage was constructed to the east of and adjacent to the service center facility.[146] The southwest corner of this building is atop the former "Holder 3" pit, or tar/water separator.[147] The garage building is clearly visibly on the 1974 aerial photograph of the site.[148]

Finally, between 1974 and the most recent air photo coverage dating to 1989, superficial changes to the facility were documented, such as the shifting of the utility pole stockpile area from the northeast corner of the site to southeast of Saratoga Gas Light Company Gasholder No. 2, and the addition of recent fill to the formerly damp area behind the historic, pre-1928, Trolley Line in the southeast corner of the facility.

DESIGN INFORMATION AND STRUCTURAL DESCRIPTION

Architect/Engineer/Fabricator/Erector

The architect/engineer/fabricator/erector of the Saratoga Gas Light Company Gasholder No. 2 House is not known. The Troy Gasholder House (HAER No. NY-2), Troy, New York, was designed by Frederick A. Sabbaton (1830-1894), a specialist in gasworks construction. Sabbaton came from a family of engineers. His father, Paul A. Sabbaton, prepared the plans and specifications for the Clermont gasworks and at the time of his death was a gas engineer. Sabbaton's two brothers and two sons were all employed as gas engineers. Sabbaton at various times supervised, constructed, and owned gasworks in Connecticut,

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[139]Ibid.
[140]Ibid.
[141]United States Environmental Protection Agency [USEPA], *Site Analysis, Niagara Mohawk Power Corporation, Saratoga Springs, New York, TS-PIC-89050*, 1989.
[142]Ibid.
[143]Atlantic Environmental Services, Inc. 1992.
[144]United States Environmental Protection Agency 1989.
[145]Atlantic Environmental Services, Inc. 1992, p. I-23.
[146]Ibid.
[147]Ibid., Figure 1-I4.
[148]USEPA 1989, Figure 6.

Massachusetts, and New York.[149] Since Troy is located less than 40 miles away from Saratoga Springs and the Sabbaton family was so involved in gas manufacturing activities throughout the area, it is possible that some member of the Sabbaton family was involved in the creation of Saratoga Gas Light Company Gasholder No. 2. Unfortunately, no records on the design, fabrication, and erection of Saratoga Gas Light Company Gasholder No. 2 House exist.

Architectural Description of Saratoga Gas Light Company Gasholder No. 2 House

The Saratoga Gas Light Company Gasholder No. 2 House is a brick masonry structure approximately 70 feet in diameter and 30 feet tall, with walls approximately one foot thick. Seven brick pilasters are placed at regular intervals around the exterior of the structure. Each is approximately one foot thick and extends the full height of the wall. The lower two to three feet of the exterior wall have been parged and most of the parge coat has now chipped away, leaving ghosts in some places. The exterior walls are broken at regular intervals by a series of five tall, narrow windows. A single entry door and a large garage door are located on the south side of the building. The structure is capped by a conical roof covered with slate shingles.

The bricks have weathered to a soft reddish brown color. The maker of the bricks is not known. The bonding pattern is common bonding or American variant of the English bond (one row of headers and seven rows of stretchers). Aside from the pilasters that encircle the structure, there are no decorative features. The pilasters, while acting as support mechanisms, in conjunction with the window placement actually provide a decorative touch by rhythmically breaking the wall space. The building has no corbelling. Brick patching that accompanies the replacement windows suggests that arches may have been a part of the original windows. If so, these arches would have been the only real decorative elements.

The walls show signs of moderate to severe deterioration of the brick and masonry joints due to age and exposure to the elements, as evidenced by large cracks in the masonry (only some of which were patched). Further, portions of the brick walls bulge from the weight of the roof and the stress of its conversion from a gasholder house to a garage. [150]

The Saratoga Gas Light Company Gasholder No. 2 House features a single entry door and a large rolling garage door on the south side. The current wood paneled door is in very poor condition and has been fortified by a piece of plywood. None of the original hardware associated with the door is extant. Currently, a hasp serves as a knob and as a place to hang a lock. Since all the openings (windows and doorways) show signs of replacement, it is not known if the current position of the doorway reflects original construction. Some time before 1938, the date of the first photograph showing the Saratoga Gas Light Company Gasholder No. 2 House as a garage, a garage door was fitted into the building. This large wood paneled door is operated through the use of a pull-chain mechanism. This hardware appears to be original.

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[149] Waite 1973, p. 44.

[150]Douglas R. Cahill, P.E. (Hazra Northeast), Letter to Mr. William R. Jones of NMPC, RE: Evaluation of an Existing Former Gasholder House (Round House #2) Scheduled for Remedial Excavation at Saratoga Springs, New York State, October 21, 1996, p. 2

The Saratoga Gas Light Company Gasholder No. 2 House has five windows located at equal distances around the structure. The tall narrow metal hopper 6/6 windows have awning sashes. Although the current hopper windows are located in original window positions, they are metal industrial replacements. The patches resulting from the replacement of the windows are apparent. The shape of the patches would seem to indicate that the original windows had arched tops, which would not have been uncommon for windows during the late nineteenth century; however, there is no documentary information to determine the original configuration. The exact purpose of the windows is not known. Perhaps it is decorative, a tool for breaking up large expanses of wall, or perhaps the movement of the interior equipment could be monitored without actually going into the house. It is also possible that the windows served the simple function of lighting the interior of the structure. Whatever their actual uses, windows appear on all early gas holders. Since the windows were boarded, it was impossible to get a feeling for the amount of natural light originally cast through the windows.

The roof slate shingles appear to be original. They are gray-green in color and are sporadically intermixed with muddy gray-red slates. The manufacturer of the slate shingles is not known. The apex of the roof was probably topped by a finial (possibly a lightening rod or a weather vane, two common rooftop accouterments for the period), as evidenced by an extant support spire. Unlike other more elaborate gasholder houses, such as the Troy Gas Light Company Gasholder House (HAER No. NY-2), the Saratoga Gas Light Company Gasholder No. 2 House does not have a cupola. Instead, the west side of the roof apex is broken by an awning-sashed vent and accessed by a ladder located in the roof's interior. The conical roof sits directly on top of the brick wall and features an eave overhang of approximately one foot. This overhang has helped protect the top approximately two feet of the brick structure from damage by wind, rain, and sun. There is a marked weathering difference between those top feet of bricks and the ones below.

The interior of the Saratoga Gas Light Company Gasholder No. 2 House has been extensively altered. The gasholder and roller tracks have been removed and a concrete floor has been laid over 20 feet of fill. Electricity has been added to the structure through the use of a wire conduit tacked to the interior walls about 12 feet above grade. The conduit breaks through the wall on the southwest side of the building and several large lights have been randomly placed on the interior walls. On the east and west sides, internal heating units have been attached to the walls. In both cases the wall was broken to provide ventilation for the units. The first two feet of bricks above grade in the interior of the structure show signs of leaching, as evidence by the white grainy film on the bricks. While the interior shows no sign of ever having a parge coat, it does appear that a portion of the interior was painted at one time.

Because of continuing problems with birds entering the structure, a wire mesh barrier was installed across the rafter base. While the mesh may have kept the birds out of the building proper, it did not prevent birds from roosting in the interior roof areas. At present, the mesh is covered with bird excrement and feathers, and every movement within the building stirs up a fine dust of these items. Because of this environmental hazard, the structure was sealed in 1998 and deemed unsafe for continued use.

> The roof structure is constructed of wood framing utilizing three (3) major, clear span, wooden trusses that support "stick framed" sloping roof rafters and ceiling joists. These members are located in a configuration that makes the shape of an inverted cone. ... With the exception of one of the three wooden trusses, the wood roof structure is also supported on the exterior wall of the structure. One end of one

of the main wooden roof trusses is supported by a large, 20-inch diameter wood pole/column. This pole/column appears to be supported directly on the existing concrete floor slab. It is believed [that] the large wooden pole/column is providing the main structural support for the one end of this major wooden truss and may have been added to support a potentially rotted end bearing condition. Also, it appears that at some point in time some rework was done around the existing overhead door opening. For whatever reason, new masonry was installed in a "triangular shape" above the door opening. The overhead door was "cut into" the masonry wall and lies directly below one of the main roof truss members. Since this section of the wall must carry a major portion of the roof load, the need for the observed repair indicates modern changes to the structure have compromised its structural integrity.[151]

The below ground foundations of the remaining gasholder house in question [Saratoga Gas Light Company Gasholder No. 2 House] is assumed to be similar in construction to the foundation remains found for a "sister" gasholder house [Gasholder No. 1] that was demolished sometime in the past. It is believed that the "sister" gasholder house was constructed around the same time as the remaining gasholder house. Based on the information contained within the "Stage IB Cultural Resource Presence or Absence Survey" mentioned above, it is believed the existing foundation is also constructed of brick masonry, approximately 18 to 24 inches thick with larger piers located around the perimeter to match the piers in the superstructure above. These foundations are believed to be approximately 20 feet deep. Based on the photographic record contained in the Stage IB report, the below grade foundations appear to be in a severely deteriorated condition due to the effects of weathering and exposure to contaminants. Originally, the structure was open on the inside (no backfill on the inside of the foundation walls). However, at some point in time, the building was no longer used as a gasholder house and was converted to a storage garage. ... [A]t some point in time the interior of the structure was filled with a variety of backfill materials, including construction debris, and was capped off with a concrete floor slab.[152]

GEO-ARCHAEOLOGICAL ENGINEERING HISTORY AND RECONSTRUCTION[153]

One of the most intriguing questions surrounding the archaeological investigation and documentation of the historic gasworks facilities at Saratoga Springs concerns the issue of how and why the nineteenth century engineers were able to construct the large, over 20-foot deep, gas holding structures where they did, given the environmental context and existing high water table conditions within the facility today. As defined by one of the original research issues, did the engineers use standardized construction techniques or site specific approaches and designs? Given the 20-to-23-foot depth of the gasholder

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[151]As per NMPC's Scope of Services with PCI, the structural description of the roof and below ground foundation has been taken directly from Douglas R. Cahill, P.E. (Hazra Northeast), Letter to Mr. William R. Jones of NMPC, October 21, 1996, pp. 2 and 3, respectively.

[152]Cahill 1996, p. 3.

[153]Grossman and Associates, Inc. 1993, pp. 60-69. This section is taken directly from this referenced report with minor alterations.

substructures below modern grade, did the original post Civil War era Saratoga Gas Light Company engineers utilize "standardized" de-watering systems and shoring structures to defeat the high water table in the process of laying the deeply buried brick foundations of Gasholders Nos. 1 and 2, or did they use different and possibly site-specific methods? Finally, how did the high water table and associated site geology affect the design and construction of the original and later gasholders, or were there models derived from prototypes which were in fact already previously designed for this set of site conditions?

In response, a number of parallel and independent lines of combined geotechnical and archaeological data can now be brought together in conjunction with a fresh review of available historic engineering documents, to suggest a new model of how this early gas facility may have been constructed within the marshy lowlands of the Village Brook's drainage in the first decade after the American Civil War. This reconstruction suggests a sequence of initial intensive site alteration and landscape reconstruction procedures that are somewhat at odds with previous characterizations of the subsurface geomorphological history of the site. Until these multiple data sets were integrated and evaluated in tandem, it had been assumed that the recent fill which constitutes the upper 7 to 15 feet of the site's stratigraphic sequence had been laid down over an extended period to create an artificial surface over the original marsh and bog sediments in this area of the Village Brook drainage as a platform, or based, into which, or through which, the earliest subsurface brick gasholders houses (Nos. 1 and 2) were constructed.

Based on the field data collected in 1992 and 1993, it now appears reasonable to suggest an alternate model of the engineering history of the gasification plant at the site. Specifically, this revised interpretation of the engineering history of the site has been developed based upon the multidisciplinary integration of the archaeological results pertaining to the earliest gasholders structures (Gasholders Nos. 1 and 2), the subsurface archaeological stratigraphic and geotechnical profiles and depth data, and finally, the incorporation of historic guidelines from a nineteenth century "textbook" treatment of the subject. As will be described in detail below, this new explanation of how the facility may have been originally constructed, is of relevance to both the engineering history of this specific site, as well to the evaluation and investigation of other gasworks facilities throughout New York state.

This historic engineering model also holds points of direct relevance to the ongoing analysis and evaluation of current subsurface conditions and vectors of contamination, which have been, and may continue to be, affected by both current subsurface conditions and past alterations to the original landscape and subsurface stratigraphy. In essence, this archaeologically derived interpretation of the geomorphology and historical engineering history of the site argues that there is direct functional and historical correlation between the depth of the earliest brick gasholders, and the depth of the basal deposits of lacustrine clay, and that the nineteenth century engineers utilized wide-area excavations, together with shoring, down to the underlying substrate of impermeable lacustrine clay to form the bottom and exterior water seals for Gasholders Nos. 1 and 2 prior to and during construction, and without the use of cement or mortared brick bases. It is also highly probable, and the available historical engineering accounts substantiate, that the depth of the buried brick holders would have necessitated the use of de-watering prior to and during the construction to drain the water-logged peat, sand deposits, and standing water out of the construction area. In this historic context, the 7-to-10-foot thick layer of historic fill was laid down during, or more precisely immediately after, the construction process to provide structural and hydraulic stabilization for the subterraneous and above-ground brick gasholder houses.

Based on this reconstruction it is further argued that the selection of this locale for the construction of the gasification plant was not based solely on the issue of elevations vis-à-vis the piping of gas in and out of the facility, nor simply the acquisition of inexpensive property with a readily available water supply or rail lines as the primary determining factors. Instead, this archaeological model suggests strongly that the siting of the gasification plant may have in fact represented a carefully reasoned engineering decision based on the availability of a specific set of soil, water table, and appropriate basal clay deposits which were viewed as critical for the successful construction of deep underground gas facilities, given the technology of the time.

The Gasholder Chronology

In addition to establishing the actual location, dimensions, and structural characteristics of each of these gasholders, the archaeological excavations identified chronologically consistent changes in technology at the site based on identified and dated distinctions in construction techniques, and materials. The results of this field work suggests that, based on the structural characteristics observed as a result of the archaeological investigations alone, the earliest structures were distinguished by being constructed of brick with below groundwater seals, and showed both consistencies and uniformity in design, construction techniques, and wall thickness. The earliest brick gasholder structures (Gasholders Nos. 1 and 2) were constructed between 1868 and 1873 apparently using the same, or very similar, elements of style and techniques of construction. Both were circular brick structures measuring approximately 2 feet in wall width, and both were structurally augmented through the addition of 5 to 6 external rectangular brick buttresses which added strength to the above ground portions of both structures.

After 1897, all subsequent gasholder structures (Gasholders Nos. 4, 5, and 6) used significantly different construction techniques and materials than the three earlier below grade brick structures. While general descriptions and photographs of these more recent gasholders (which characterized them as above ground steel tanks built on cement slabs at grade) were available prior to the archaeological investigations, the archaeological data recovery, in addition to fixing their actual location and dimensions, provided specific and detailed information on the structural characteristics, construction techniques, and stratigraphic context for Gasholders Nos. 4 and 6 which significantly contrasted with those of Gasholders Nos. 1 and 2, and "Holder 3." Gasholder No. 4, identified at a depth of approximately 3 feet below modern grade, proved to consist of a large free form slab or base of cement, with a second molded cement floor into which was set the steel basal ring which formed the base of the water seal of the lower shell of the approximately 40.6-foot diameter structure. The composite cement slab/steel above-ground construction employed for Gasholder No. 4 was initially applied in Saratoga Springs sometime around 1897, based on the previously established site history.[154] Similar composite cement/steel construction techniques also appear to have been used in the building of the most recent 500,000 cubic foot "triple lift" steel holder of Gasholder No. 6 in 1924. As was the case for Gasholder No. 4, Gasholder No. 6 was constructed with a cement base for the interior floor of the steel water tank and water seal of the gas container.

Taken together, these contrasts in construction technology and design through time indicate that the engineering history of the gasholder structures at the Saratoga Springs facility can be divided into two major time periods, or phases, of engineering design and construction techniques.

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[154]Atlantic Environmental Services, Inc. 1992.

These chronological and technological distinctions reflecting changes in construction techniques of the gasholders are paralleled by another set of technologically significant contrasts in the depth of construction and the changing nature of the subsurface gas/water seals for the tanks through time. The early brick gasholders houses (Gasholders Nos. 1 and 2) were both built with deep bottoms using water seals and floating interior metal shell gasometers to a considerable depth below modern grade.

While the Atlantic Environmental Services (1992) site history dates "Holder 3" construction as being from 1889 to 1903, its brick construction design and similarities to Gasholders Nos. 1 and 2, suggests that in fact, "Holder 3" pre-dates the cement and steel construction of Gasholder No. 4 at the site, which was constructed in 1897.[155] The time span of the earliest phase of below-grade brick based gas house construction techniques can be dated to between ca. 1868 with an end date of sometime between 1889 to 1897. Given the similarities between Gasholders Nos. 4, 6, and apparently Gasholder No. 5, consisting of above-ground holders built with cement bases and steel superstructures, the time span for the second phase at Saratoga Springs can be fixed as spanning between 1897 to 1924.

These contrasts in the distinctions between the early and later phases suggests that a significant shift in the engineering technology of gasholder construction appears to have occurred at the Saratoga Springs facility after 1897. In addition to their structural distinctions, and the use of different materials and techniques for their construction, these chronological differences correspond in general with the need for larger storage capacities, and then later, the post-1930 shift from coal gas production to only the storage and distribution of water gas, which was still being manufactured at Schenectady and Troy facilities and then was piped to Saratoga Springs.

As a final caveat, it is important to note that while this shift may be chronologically consistent, early documentary sources suggest that the changes were not necessarily driven be technology alone, and may have reflected more economic pressures than the availability or advent of new gasholder construction techniques through time. The issue of the relative fiscal merits, and actual contemporaneity of brick versus cement gasholder construction techniques was explicitly addressed by John Hornby, a British specialist in the field, in a late nineteenth century "textbook" on gas manufacture, published in London in 1896.

> Tanks are constructed of brick, stone, or concrete, according to circumstances, the material employed largely depending upon the materials most cheaply obtainable in the locality, and the nature of the ground in which it is proposed to construct the tank, which in some instances necessitates the employment of tanks constructed of cast or wrought iron plates bolted or riveted together, but such tanks are only employed under very special circumstances, as their cost is much greater than either brick or stone.[156]

Gasholders Nos. 1 and 2: The Geotechnical Evidence

This archaeological evidence concerning the structural characteristics and absolute depth of the early phase gasholders relative to the geological data combines to suggest how the original brick gasholders

[155]Ibid.; Atlantic Environmental Services, Inc. 1990.
[156]Hornby 1896.

may have actually been constructed within the waterlogged marsh environment of the Village Brook drainage. The key lines of evidence concern the absolute depth of the gasholders relative to the absolute depth of the underlying lacustrine clay, as documented by the 1990 to 1993 boring records and resultant geological cross sections through the site.[157] Two profile sections, in particular, reproduced in the 1992 draft report by Atlantic Environmental Services, augmented with new boring data recovered in 1993, combine to suggest how Gasholders Nos. 1 and 2 could have been built to a depth of 23 feet below modern grade through what is now permeated by the near surface water table throughout the northern portion of the project site. Borings within the interior of Saratoga Gas Light Company Gasholder No. 2 House showed a refusal and/or a brick or cement base at a depth of 23 feet below grade.[158] Borings within Gasholder No. 1, built at the same time as Saratoga Gas Light Company Gasholder No. 2, showed no surviving evidence for a brick or cement interior bottom, and only the presence of impermeable lacustrine clay at the bottom of the holder which suggested, as will be expanded upon below, that the clay formed the primary base of the water seal for this early gasholder structure.

Two geological profile sections in particular (designated A-A' and D-D') serve to provide exterior north-south and east-west geological profile sections in the vicinity of Gasholders Nos. 1 and 2.[159] Both profiles document a general pattern of historic nineteenth century fill down to a depth of 7 to 15 feet below modern grade, extending between elevations 270 and 255 feet in absolute elevation. Below this historic fill, the profiles document a sequence of four naturally deposited layers. The uppermost subfill deposit consisted of a stratum of fine-grained water-borne sands and silts, designated the "Upper Fluvial" averaging 3 to 7 feet in thickness, which suggests deposition from a slow moving water source or stream flow. Beneath this "Upper Fluvial" sand layer was a uniform deposit, ranging in thickness between 3 and 9 feet, of dark organic peat indicative of a static marsh habitat with little water flow. Below this "Peat" layer was a deposit of coarser sands and gravels, designated the "Lower Fluvial," reflecting deposition through former more rapid, or higher velocity, water sources. Finally, at the base of the sequence, the entire site was underlain by a uniform 50-foot thick deposit of "Lacustrine" clay of glacial origin characterized by the presence of laminar lenses, or varves of interbedded fine sands reflecting sequential episodes of gradual sedimentation.

The presence of this underlying stratum of glacial clay is of critical significance because it appears to have constituted what may have been one of the primary geological variables operating in the selection of this locality for the construction of the gasworks facility. The depth of the basal clay deposit is important because the brick substructures of Gasholders Nos. 1 and 2 appear to have been constructed down to, and into this stratum, and because the clay can now be interpreted as technologically essential for providing the primary barrier or basal seal for containing the water within the subterranean brick gasholder tanks.

This geotechnical evidence suggests that the nineteenth century engineers utilized the presence of natural basal deposits of impermeable lacustrine clay in selecting the site so as to seal the bottoms of the circular brick gasholders, and to pack the exterior of each gasholder with an outer ring or cone of watertight clay to address issues of permeability, pressure, and elasticity of the brick gasholder from these same basal deposits.

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[157]Atlantic Environmental Services 1992.

[158]Ibid.; Terry Taylor, personal communications March 12, October 20, and October 23, 1993. Re: Boring Log information. Atlantic Environmental Services, Inc., Colchester, Connecticut.

[159]Atlantic Environmental Services 1992.

The suggestion that a functional correlation exists between the depth of the brick holders and the role played by the underlying impermeable lacustrine clay deposit is not only suggested by the geological and archaeological evidence, but is also explicitly described in a late nineteenth century textbook by John Hornby on the construction of gasholders published in London in 1896. In his discussion he highlights the use of clay both to form the bottom seal of the subterranean base of the brick gasholder, and to deal with problems of water pressures and elasticity on the exterior.

> [A]fter the necessary excavation has been made, which is to be well shored up and strutted, a layer of puddle 2 feet thick, prepared from good stiff clay by well soaking it with water, cutting it up, and turning it over until it becomes a soft, homogenous mass, is first put all over the bottom and under the brickwork footings, and portions of the circular wall of the tank is raised, say, 3 feet high. Puddle is then thrown in between the excavation and the brickwork, and this is continued until the necessary height is obtained ... and the [brick gasholder's] weight over the bottom ... prevents the bottom from blowing and the nuisance and expense of a leaky tank.[160]

This interpretation is augmented by an additional line of boring evidence which indicates that the clay deposits recovered beneath the tank of Gasholder No. 1 evidenced horizontal bands or varves, suggesting natural deposition, while the clay recovered from the exterior of Gasholder No. 1 was a homogenous, non-striated matrix of apparently artificially mixed clay.[161] This contrast between the apparently artificially raised deposit of mixed clay surrounding the exterior base of the gasholder versus the unmixed natural clay deposits beneath it is suggestive of the process of exterior clay packing described by Hornby in 1896.

In addition, Hornby expanded his nineteenth century discussion to include an explanation of the role or technical function played by the use of secondary fill deposits around subterranean brick gasholders to address the problem of lateral water pressure on the brick walls.

> In a brick and puddle tank the pressure due to the water it contains is transmitted through the porous brickwork to the clay puddle and earth backing, which are slightly elastic ...; and their stability largely depends on the selection of the material to form the earth backing, and the care with which this is filled in, rammed, and watered.[162]

Thus, from these historical engineering accounts, it is now apparent that the absolute depth of the earliest brick gasholders at Saratoga Springs, and their construction down to, and apparently into, the underlying lacustrine clay was neither a coincidence nor a circumstantial (or arbitrary) decision on the part of the original engineers. Given the clearly defined role that clay "puddle" was perceived to play in forming the bottom seal of the brick holder, and given the need to address problems of permeability and elasticity of the brick gasholder water tank wall with an outer lining of clay, it now seems highly probable that the presence of the naturally-occurring, impervious deposit of lacustrine clay at 20 plus feet below modern

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[160] Hornby 1896, p. 143.

[161] Taylor, personal communication 1993.

[162] Hornby 1896, p. 140.

grade, not only functioned as an integral part in the original design and construction process, but also may have in fact constituted one of the primary engineering motives for selecting the site for the coal gasworks facility in the first place.

The Interior Dumpling

Finally, this late nineteenth century textbook description of the construction process for brick gasholders of the period contained an additional insight concerning the form of the base of the gasholder which is generally relevant for both interpreting the subsurface characteristics of Gasholders Nos. 1 and 2 in general at the site, and of specific relevance to the interpretation of geotechnical or boring data, which has been, or may be, collected from the interior of these or other similar below-grade nineteenth century brick gasholders. What these early accounts clearly document is that the bottoms of the open cut brick gasholders were not flat, but instead conical and raised in cross section. Hornby describes the particulars of the recommended and apparently standardized engineering procedure as follows:

> In order to save expense, both in labor and water, it is usual to leave a portion of the center of the tank untouched. This unexcavated portion is known as the 'dumpling,' and it is also necessary to puddle up the sides, and over the top of this dumpling, so as to make the tank water-tight. This dumpling serves to support the king post of a trussed gas-holder; or if the holder is of an untrussed type, the timber framing which supports the roof when the holder is down.[163]

This explicit description reveals several facets of brick gasholder construction of relevance to the construction of the early brick Gasholder structures 1 and 2. To begin with, the description clearly implies that the base or bottom of the brick gasholder was cut into the open basal soil deposits, and that the cone was, at least for this early phase of construction, simply composed of unexcavated materials, in this case clay, left in a conical shape. This description also specifies that this unexcavated cone or dumpling was sealed with a layer of mixed clay puddle as a secondary coating to seal and make watertight the base of the gasholder tank. Such a coating may or may not have been necessary if the basal deposit was of clay, as was the case at the Saratoga Springs facility.

Finally, this historic material, when taken in conjunction with the most recent boring data suggesting that the interior bases of Gasholders Nos.1 and 2 may have indeed been composed of clay, points to an area of potential ambiguity for the engineering interpretation of interior boring records. If the base of construction was indeed formed out of the parent material as a cone of unexcavated soil or clay, then the possibility exists that boring records indicating the advent of clay could be erroneously recording the apex or upper tip of this cone versus the actual base of the brick structure. In other words, the possibility exists that assuming the presence of such a dumpling or cone beneath Gasholders Nos. 1 and 2, the recorded advent of clay in the boring column could in fact be several feet, if not yards, above the actual basal depth of the brick structure at its sides. Accordingly, all boring records from the interior of these and comparable brick gasholders should be carefully evaluated relative to the location or distance from the brick gasholder walls, which could be considerable deeper than indicated by boring columns taken at the center or conical "zone of dumping" within the structure.

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[163]Ibid., p. 142.

Historic Construction Phases

Taken together, these archaeological, geotechnical, and historical documentary lines of evidence suggest that the initial nineteenth century construction of Gasholders Nos. 1 and 2 may have progressed in four possible stages.

De-watering

At the same time as the open cut excavation was initiated, the engineers would have faced the need to address the problem of de-watering the waterlogged sand and peat deposits through the use of traditionally proscribed sinking of a number of wells or sump holes. Regardless of whether they utilized vertically excavated brick lined sump holes or open drainage ditches to de-water the site, the need to de-water during the initial phases of construction in the 1870s clearly played a central role for establishing the engineering feasibility of constructing the early brick gasholders, down to the depth of the underlying lacustrine clay deposits. In his 1896 textbook on the manufacture of gas, Hornby explicitly stressed the need for, and provided detailed guidance on how this initial de-watering process should proceed.

> Before adopting any particular site for the construction of a tank, it is necessary to sink a well or shaft in the vicinity, or to sink a number of trial borings in close proximity to the site in order to ascertain the nature of the strata in which the excavation of the proposed tank has to be made. If any considerable quantity of water is found, it will then be necessary to make provision for its continuous removal during the progress of the work in the following manner.
>
> The first thing to be done is to sink a well or sump 3 to 4 feet in diameter at a convenient distance from the circumference of the proposed excavation. This should be lined with open, unmortared brickwork (technically called steining) to allow of the free percolation into the well or sump through the joints of the lining...
>
> This well is carried down to a depth of 3 to 5 feet (depending on the volume of water present) below the bottom of the intended excavation and is then paved with brick set in cement. If the strata are of uniformed open character, consisting, say, of a mixture of gravel and sand, one pump will be sufficient to clear the ground of water; otherwise, if it is not uniform but barred by intervening clay deposits, and even by solid bedded sand, for this sometimes is almost as impervious as clay, it may be necessary to drain the water to the sump, or even put two or more sumps outside the ground operated on.[164]

This historic citation is of immediate relevance to the understanding of the construction history at the Saratoga Springs site, because in addition to stressing the need and the role of de-watering as an integral part of the overall construction process, it both highlights the significance of the impermeability of the clay, and suggests the option of using open drainage ditches as an alternative method for removing large volumes of standing water prior to, or during, construction. Accordingly, the possibility exists that given the high water table conditions at the site, the large volume of water derived from the lateral flow from

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[164]Ibid., pp. 140-141.

nearby springs associated with the rift or escarpment immediately to the north of the site, the possibility exists that either sumps or large open ditch drains into the Village Brook channel were applied in this setting to facilitate the deep construction of the original brick gasholders.

Construction and Shoring

The construction involved the opening of wide cut pits, or trenches with the appropriate level of shoring in the locations of Gasholders Nos. 1 and 2 that measured at least 10 to 20 feet beyond the ca. 70-foot outer diameter of each gasholder, sufficient to accommodate shoring and the deposition of the outer berm or cone of clay. As quoted above, Hornby's explanation referred to the use of shoring with the admonition that the excavation must be "...well shored up and strutted..." as an aside which implies that this was in fact a standard procedure for late nineteenth century construction of below-grade gasholders.

Use of Clay for the Base of the Gasholders

The construction Gasholders Nos. 1 and 2 was initiated and built into the cleared lacustrine clay base as the primary seal for the interior of each structure. The boring records within the interiors of Gasholders Nos. 1 and 2 indicate that the base of both brick structures extended down into the clay. No evidence exists to suggest that either Gasholder No. 1 (Boring (H91/2) or Saratoga Gas Light Company Gasholder No. 2 House (Boring B5) showed the presence of an identifiable brick or cement floor at their bases.[165] Fragments of brick recovered from various depths from previous boring columns can be interpreted either as the ephemeral remains of a brick floor or, more conservatively, given the composition (cement, brick, and stone) of the historic post-demolition fill, as element of the fill as was evidenced archaeologically within the interior fill of "Holder 3." This geotechnical and archaeological evidence is corroborated by Hornby's explicit description of the use of "puddle" over the bottom of the brick walled holder, as follows: "... a layer of puddle is put over the bottom and under the brickwork footing."[166]

Creating an Exterior Clay Water Seal

Hornby went on to stipulate that in addition to the use of an "earthen backing" to strengthen the above ground portions of the brick gasholder, the walls were made, "... water-tight by being surrounded on the outside with clay puddle of from 12 to 24 inches in thickness...".[167]

In light of this historical documentation, it is relevant to stress that the 1993 engineering boring data appears to suggest the presence of an artificially raised embankment of clay or puddle in the vicinity of the exterior of Gasholder No. 1.[168] Two of the most recently available borings, designated EXPD-1 and EXPD-2, situated immediately north of the exterior brick wall of Gasholder No. 1, and with a lateral distance of some 30 feet between the two borings, document that the relative depth of the clay rose steeply by a factor of some ca. 7 to 8 feet around the exterior subsurface base of the gasholder. In light of Hornby's explicit nineteenth century engineering discussion of the role of clay puddle to pack the exterior base of brick gasholder houses, this geotechnical information from the boring record suggests that at least

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[165]Taylor personal communication 1993.

[166]Hornby 1896, p. 143.

[167]Ibid., p. 140.

[168]Taylor, personal communication 1993.

Gasholder No. 1 and probably Saratoga Gas Light Company Gasholder No. 2 may have been intentionally constructed using this technique, and using the naturally available lacustrine clay deposits which underlay the site.

Based on the geotechnical boring data recovered this year, at least one of the subsurface stratigraphic sections suggests strongly that the exterior of both Gasholders Nos. 1 and 2 were packed with a raised conical embankment of lacustrine clay which would have been mined from the basal deposits of the project site itself as a primary exterior water seal for these gasholder structures. The presence of these exterior clay embankments, in conjunction with the archaeological evidence that no inner liner of cement or sealant was used in the construction of Gasholders Nos. 1 and 2 augments the interpretation that the original water seal was established through the application of both interior and exterior deposits of locally available clay.

CURRENT STRUCTURE SETTING AND STATUS

At present, the Saratoga Gas Light Company Gasholder No. 2 House is part of Niagara Mohawk Power Corporation's Saratoga Springs plant. Small wetlands can be seen to the west and east of the site area. Immediately to the south of the plant is Red Spring, one of Saratoga Spring's many mineral springs that were famed for curing skin conditions. Approximately a quarter of a mile to the southeast on Excelsior Avenue (formerly Spring Avenue) is one of Saratoga Springs' oldest homes that has been converted into a restaurant. To the northeast on Excelsior Avenue is the Saratoga Springs Water Works building, an excellent example of the late Colonial Revival style applied to a public building. The surrounding area is mixed-use, with some residential components but the basic look and feel is light industrial.

As of this writing, the Saratoga Gas Light Company Gasholder No. 2 House is no longer in use, and awaits possible demolition in late 1998 or 1999.

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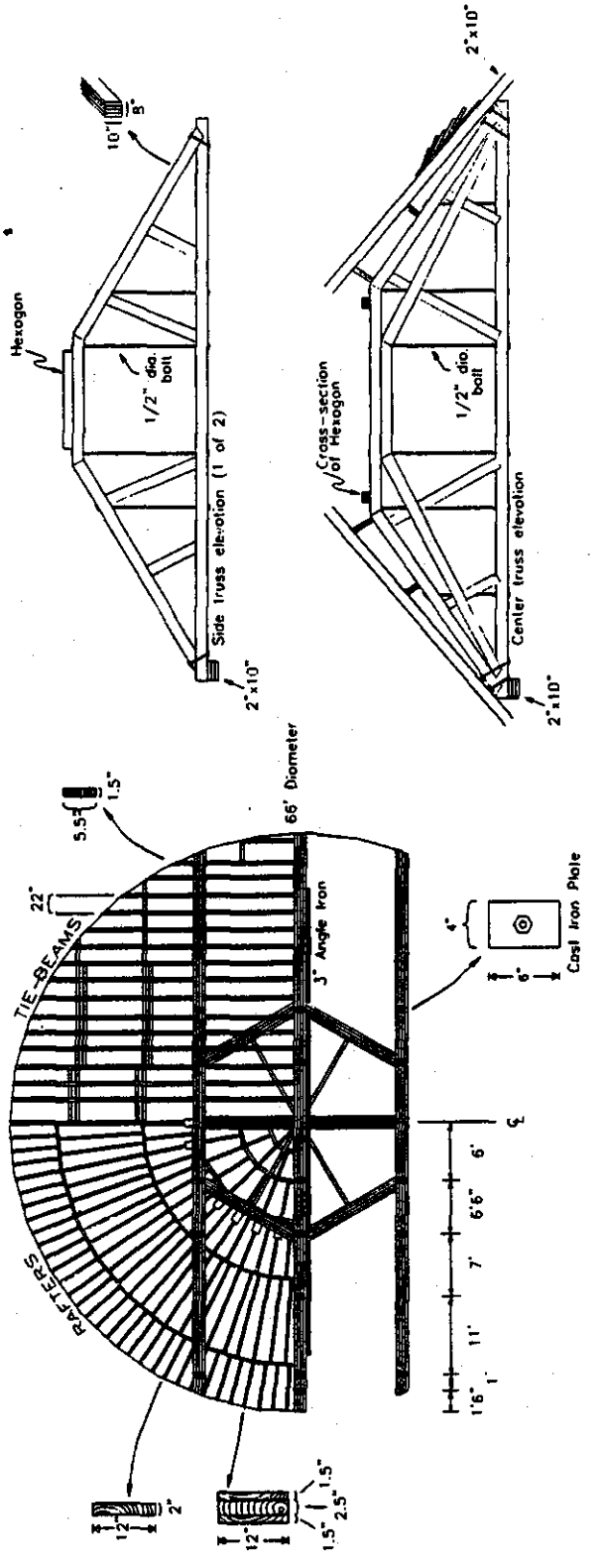

The Saratoga Gas Light Company Gasholder No. 2 House roof plan and elevation (delineated by Kendall Rich, Panamerican Consultants, Inc., 1998).